CHAPTER 6

LESSONS LEARNED

6-1. Introduction. As with many coastal engineering problems, much of what has been learned about sand bypassing has been the result of trial and error. Unfortunately, the errors seem to receive most of the notoriety, even though several sand bypassing projects have been very successful. Part of the problem is that the actual number of bypassing projects is limited, compared with beach-fill projects or jettied inlets. However, the major problem is that sand bypassing requires detailed coastal processes information that is very difficult to measure and varies widely over time and space in addition to the engineering challenges associated with working in the surf zone. Fixed plants are even more susceptible to the natural variety of sediment transport rates, directions, and deposition locations found at most sites. The difficulty in measuring the forcing functions (wave height, direction, and currents) and the processes of interest (longshore transport direction, distribution, and magnitude) has made the engineering of successful fixed systems difficult. As ability to determine the forcing functions and sediment-structure interactions improve, so will bypassing success.

a. Purpose. This review of some lessons learned is not intended to negatively highlight any individual or District. The designers did the best job they could with the information available. In fact, several sand bypassing projects designed 20 or 30 years ago continue to function very well. The purpose of this chapter is to reinforce the points made earlier in this Engineer Manual by relating some of the guidance or warnings to specific projects so that the mistakes are not repeated. Also new information that supplements or reinforces some of the references is also included.

b. Organization. This chapter is divided into two sections. The first section describes several projects where the incomplete coastal processes information, usually transport rate or direction, was not correctly estimated. In the second section, problems with fixed plants are highlighted.

Section I. Impacts of Lack of Coastal Processes Information

6-2. Introduction. Lack of thorough knowledge of the coastal processes active at the site has been the major cause of the most sand bypassing project problems. In particular, net longshore transport direction and short- and long-term rates have been a major factor in most of the projects with bypassing problems.

a. Net Direction. As noted in Chapter 4, the net direction can vary from year to year. A design based on a short data collection period or assumed drift direction can lead to problems. The failure of the bypassing project at East Pass Inlet, Florida, was due to incorrect assessment of net longshore drift direction. The decision to place the weir on the west side of the inlet was based on a short period of an unusual amount of easterly transport. As noted in Appendix E, the incorrectly placed weir was closed in 1986.

b. Onshore Migration of Ebb-Tidal Deltas. Several locations where jetties have been added to unstructured inlets have resulted in a portion of the ebb-tidal delta migrating onshore. As the channel is relocated, the ebb-tidal currents no longer keep the original delta in place, and it migrates onshore. This has happened at Ponce de Leon Inlet, Florida (Purpura et al. 1974, Purpura 1977); Murrells Inlet, South Carolina (Douglass 1987); and the Nerang River Entrance, Queensland, Australia (Figure 6-1) (Clausner 1988). This unplanned extra amount of sand can lead to increased amounts of sand getting into the channel or can require additional lengths of pipe to reach the surf zone to allow bypassing.

c. Nearshore Berms. A present area of active coastal research is nearshore berms. Potentially large benefits are possible from bypassing maintenance sand removed by hopper dredges in the form of nearshore berms. By placing material in long, shore-parallel features, the berms can provide benefits by reducing wave energy reaching the beach and/or introduce beach quality sand into the littoral system. This type of placement is generally less expensive than direct beach placement, but at present quantifying benefits is difficult.

d. Nearshore Berm Placement Depths. McLellan (1989) summarizes experience with nearshore berms. Table 6-1 lists the important features of nearshore berms used for sand bypassing, though the depths listed for some berms are now known to be too deep for effective bypassing. Research indicates that the minimum depth the material can be placed for inclusion into the active littoral zone is approximately 24 feet (McLellan 1989). It appears that relatively shallow nearshore berm placement, on the order of 7 to 12 feet, is needed to observe measurable changes to the dry beach. Additional research is

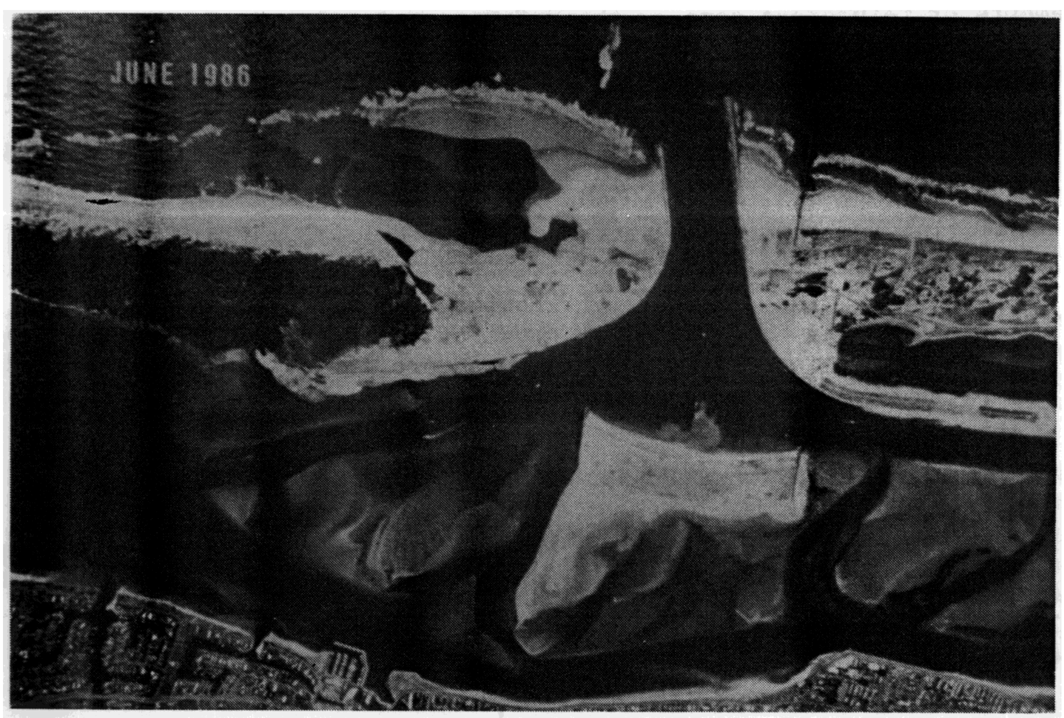


Figure 6-1. Ebb-tidal shoal onshore migration at the
Nerang River Entrance, Queensland, Australia

Table 6-1

Nearshore Berms Used for Sand Bypassing

Location	Date	Material Quantity cu yd	Water Depth ft	Mound Height ft
Santa Barbara, California	1935	200,000	22	5
Atlantic City, New Jersey	1935-1942	3.5 mil	10-26	NA
Long Branch, New Jersey	1948	600,000	38	7
Durban, South Africa	1970	10.4 mil	50	25
New River Inlet, North Carolina	1976	35,000	6-13	NA
Sand Island, Alabama	1987	400,000	18	7
Fire Island, New York	1987	420,000	16	6.5
Jones Inlet, New York	1987	390,000	16	6.5

now under way to more accurately define the combination of water depth, grain size, and wave climate to allow prediction of berm movement.

e. Cross-Shore Distribution. As first mentioned in Chapter 4, the cross-shore distribution of longshore transport is very important in the design of fixed plants and weir systems. Operating data from the Nerang River Entrance fixed plant confirm the observations that most sediment transport takes place close to shore. Table 6-2 presents the number of operating hours for each of the 10 jet pumps (spaced 100 feet apart), which roughly corresponds to the amount of sand transferred. Jet pump number 1 is farthest offshore with jet pump number 10 closest to shore. If the jet pump crater were not present, the elevation of the bottom at jet pump number 10 would be approximately mean sea level (msl). As shown in Table 6-2, a substantial amount of the sand bypassed came from the inner jet pumps.

f. Weir Systems.

(1) Weir elevation and length. The Ponce de Leon Inlet weir was 1,800 feet long and at an elevation of mlw. This too long and low weir

Table 6-2

Jet Pump Operating Hours at the Nerang River Entrance Bypassing Plant as of February 1988

Offshore		Nearshore	
Jet Pump No.	Operating Hours	Jet Pump No.	Operating Hours
1	1,085	6	1,346
2	845	7	1,777
3	1,202	8	2,209
4	922	9	2,326
5	1,774	10	2,420

elevation allowed excess ebb flow over the weir, which encouraged the chnnel to migrate up against the north jetty. Also, the too low weir (a midtide elevation is recommended) allowed an excessive amount of wave energy into the interior of the inlet, causing erosion of the land on the south side.

(2) Deposition basin location. Experience with Masonboro Inlet, Murrells Inlet, and St. Lucie Inlet has shown that the widest part of the deposition basin should be landward of the weir-shore connection. At Masonboro Inlet, the USAED, Wilmington, has expanded the original deposition basin to cover a large area that reaches back a considerable distance (Figure 6-2). By expanding the deposition basin, they have been able to reduce the dredging frequency from once each year to once every 4 years with a subsequent reduction in costs. At Masonboro, Murrells, and St. Lucie Inlets, sand is carried over and through the weir into the inlet, forming a small spit at the end of the updrift island (Figure 6-3). The potential for this occurring on future weir projects should be considered.

Section II. Fixed Plant

6-3. General. The following paragraphs describe lessons learned at fixed plants. Included are observations from Rudee Inlet, Virginia; Oceanside, California; and the Nerang River Entrance, Queensland, Australia.

6-4. Recommendations for Semimobile Jet Pump Systems. The following observations are based on the semimobile jet pump system operated at Rudee Inlet, Virginia. (Appendix E contains complete Rudee Inlet bypassing details.) These observations apply to jet pump systems in general and more specifically to semimobile jet pump systems:

a. Jet pump clogs occurred occasionally, but backflushing (described in Richardson and McNair 1981) proved to be a satisfactory clearing method.

b. Debris becomes a problem. However, jet pump mobility prevents shutting down the system for long periods. Also having a conventional cutterhead dredge onsite aided in removal of debris.

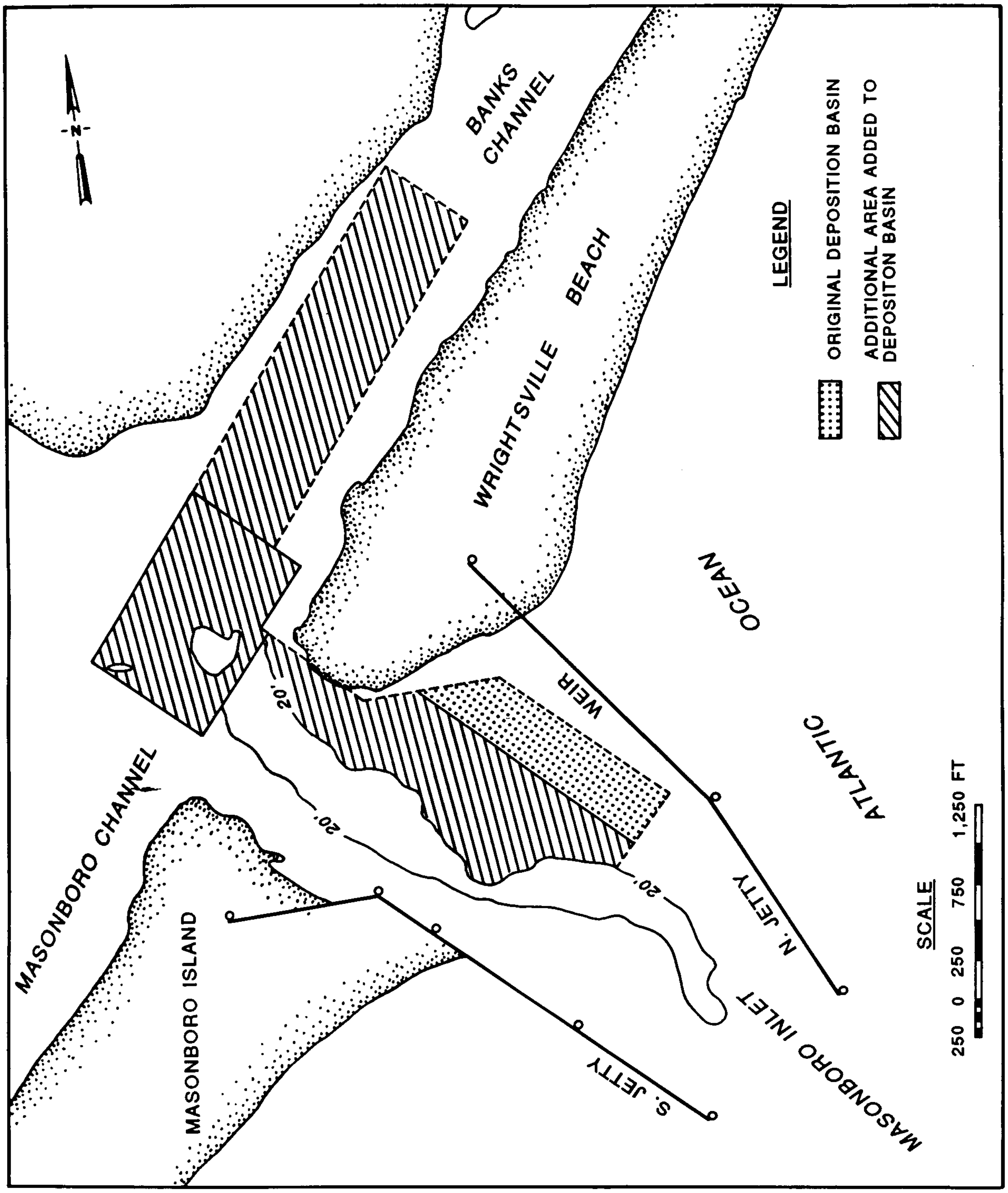
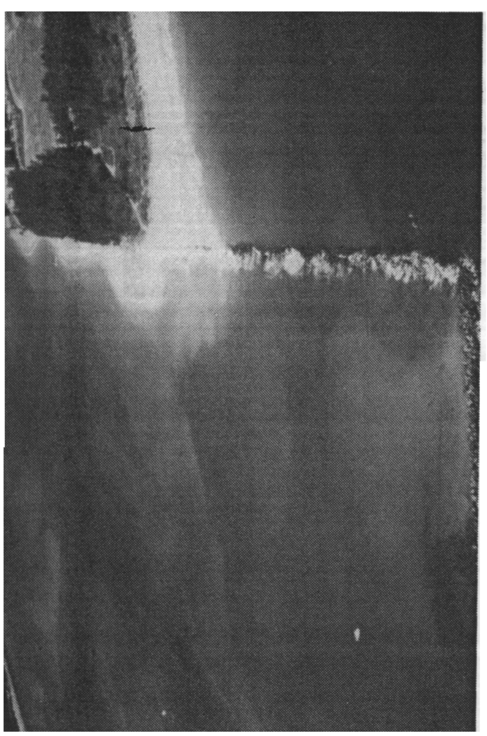
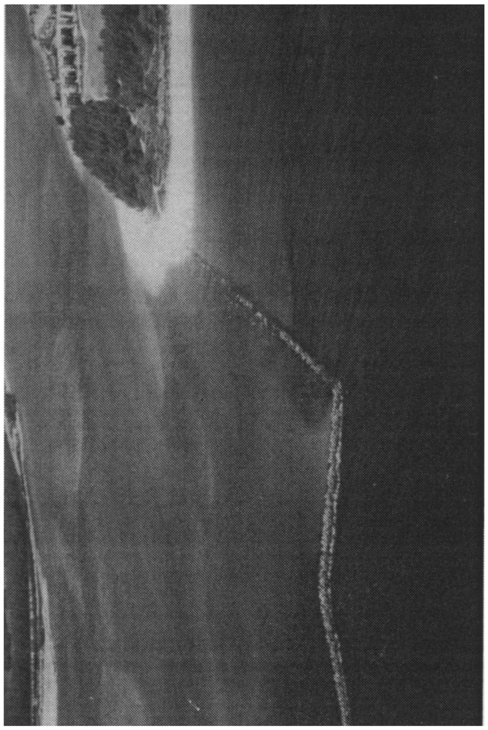


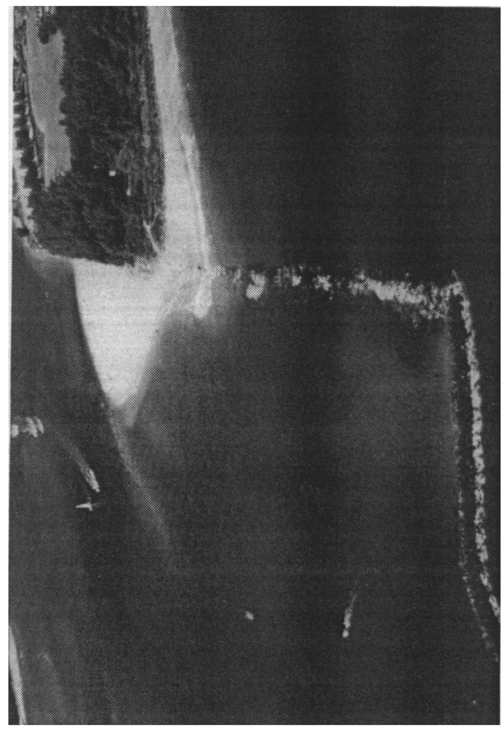
Figure 6-2. Masonboro Inlet deposition basin



a. March 1985



b. August 1985



c. December 1985

Figure 6-3. Spit formed at south end of barrier island, St. Lucie Inlet, Florida

c. Flexible hoses deteriorate rapidly, particularly at end connections.

d. The jet pump will dig its own crater. The crater sides eventually collapse over the supply and discharge lines, hindering retrieval and/or movement of the pumps.

e. Movement of jet pumps and supply and discharge hoses during rough weather is extremely difficult.

6-5. Debris. Debris continues to be the major problem for fixed plant operation. Figure 6-4 illustrates the severity of the problem at the Nerang River Entrance, Australia. It shows the amount of debris, mostly wood from the adjacent river entrance, that had been collected in a single jet pump crater over a several month period of intense wave activity. Debris of this magnitude obviously will severely reduce jet pump performance. A second major debris problem at the Nerang River Entrance has been the dune grass. The grass is eroded from the dunes during storms forming large balls and mats in the jet pump craters, effectively preventing sand from reaching the eductor. At Oceanside, California, kelp stalks up to 30 feet long have clogged jet pumps in the entrance channel. The potential for debris problems like those described forces the designer of a fixed plant, especially an eductor plant, to consider the following:

a. The eductor needs to be able to be retrieved and deployed easily with onsite equipment. Since the eductor will be placed in an area of active shoaling, plans for retrieving the eductor should include the possibility that the eductor and supply and discharge pipes may be buried by 5 to 10 feet of sand. A method to remove the eductor and piping should be considered even under these adverse conditions.

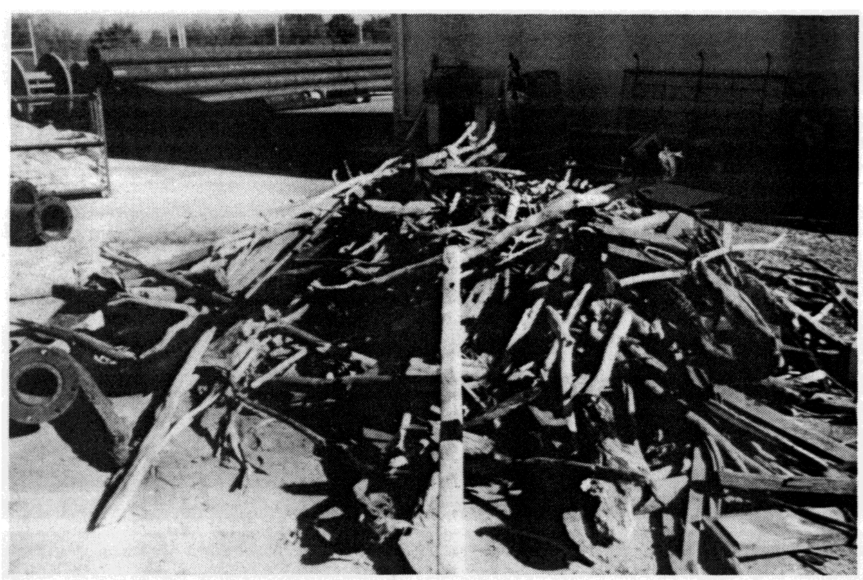


Figure 6-4. Debris removed from a single jet pump crater at bypassing plant at the Nerang River Entrance, Australia

b. An alternative method of removing major debris accumulations (once every 6 months to 1 year) at jet pump locations, e.g. clamshell, grappling hooks, etc., should be planned. This will mean that the structure supporting the eductor will have to be moved, or the eductor will have to placed some distance out from the structure. As noted in section 6-4, as the mobility of the eductor increases, the debris problem is reduced.

6-6. Craters. Craters created by eductors or submersible pumps will remain empty until significant wave activity causes sufficient transport to fill them. Offshore craters will remain for several weeks after creation unless there is significant wave action. Nearshore craters, as expected, generally fill in much faster due to increased wave influences at shallower depths. Depending on wave activity and the depth of the crater, nearshore craters may take 12 to 36 hours to fill from wave activity. During transfer, the crater may be emptied in a few hours. Therefore, to provide bypassing more sand, a single eductor or submersible pump will have to be moved during the day. Otherwise, multiple pumps will be needed to provide continuous transfer. Finally, craters in fixed locations will tend to armor the side slopes with coarser material over time, creating even steeper slopes and resulting in smaller crater volumes.

6-7. Fixed Plant Design. A fixed bypassing plant using a standard slurry booster pump is essentially a land-based dredge. Therefore, during design of the system, a consultant experienced in dredge design should be used. Fortunately for the Corps of Engineers, the Marine Design Center can provide guidance in this area. They should be consulted early in the design process.